PRELIMINARY OBSERVATIONS ON THE STATUS OF SILVER CARP IN RELATION TO CATLA IN THE CULTURE FISHERY OF KULGARHI RESERVOIR[1]

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(With two text-figures)

Introduction

The Chinese carp, *Hypophthalmichthys molitrix* (C.&V.), popularly known as silver carp, is an exotic fish introduced into India from Japan in September 1959. It is native to Chinese rivers, but has been introduced into almost all the South-east Asian countries. The work carried out at the Pond Culture Division of Central Inland Fisheries Research Institute, Cuttack has shown that silver carp is a fast growing fish, growing faster than catla and that its growth in Indian waters is faster than in its native waters. The observations further indicated that though the production of silver carp alone in a pond is over double that of catla, the presence of both in a pond seems to affect the growth of either adversely (Alikunhi and Sukumaran 1964). With this background, a small consignment of silver carp fingerlings was stocked in Kulgarhi reservoir on experimental basis on 11-2-1969. Based on the recovery of 8 specimens of silver carp (size range: 575-794 mm) from Kulgarhi reservoir during the period 2.12.69 to 4.6.71, Rao and Dwivedi (1972) have reported excellent growth of this exotic fish, thus indicating a great promise for the increased fish production from the reservoir. However, in a separate study, the comparison of growth rates of silver carp and catla from Kulgarhi reservoir has indicated that the culture of silver carp with catla in the reservoir adversely affects the growth of the latter. It is well known that the food habits of a fish have a direct bearing on its growth and survival. With a view to evaluate the status of silver carp in culture fishery of the reservoir with particular reference to catla, the observations were made on the food habits and the growth of silver carp and catla from Kulgarhi reservoir during the period 2.12.1969 to 22.12.1972 and the results thereof are reported in this communication.

Kulgarhi Reservoir:

It is situated about 85 km from Rewa in Nagod Tahsil, Satna District, Madhya Pradesh near Kulgarhi village, its geographical location being 80° 44′ 0″E longitude and 24° 28′ 50″N latitude.

The work on the construction of the reservoir was started in the year 1959 and completed in the year 1966. On the north of it, an earthen dam having a length of 1450 m and maximum height of 18.6 m has been constructed across a seasonal stream called Durha

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nalah (Ganga river basin), which originates from hills surrounding the reservoir on east, south and west sides and drains rain water from the catchment area of 10.69 sq. miles into the reservoir from south-west corner. The waste weir is located on the north-east side of the reservoir. The maximum water spread area is 193.5 hectres which was attained for the first time during 1971 monsoon season. The live storage capacity of the reservoir is 306 mc ft., whereas its dead storage capacity is only 26 mc ft.

Material and method

The construction work of Kulgarhi reservoir was completed in the year 1966. The fingerlings of major carps including catla were stocked for the first time in Kulgarhi reservoir in the year 1966 and again in the year 1968. The fry of silver carp (size range: 15-17 mm), which were obtained from Cuttack Sub-station of this Institute in September 1968, were reared in a nursery pond at Satna (M.P.) till the beginning of February 1969 and 229 fingerlings (size range: 121-216 mm) recovered from this nursery pond were stocked in the reservoir on 11.2.1969.

For comparing the growth patterns of catla and silver carp, 137 specimens of the former belonging to 1966 brood and captured from the reservoir from February 1968 to June 1972 and 12 specimens of the latter belonging to 1968 brood and captured from December 1969 to December 1972 have been utilized. The age of the individual specimen of catla and silver carp in terms of months has been determined on the basis of date of their recovery from the reservoir, assuming period of their hatching as August 1966 and August 1968 respectively.

For food studies, the guts of 11 specimens of silver carp and 11 specimens of catla obtained in the months of December 1969, September 1970, February 1971, June 1971, July 1971, March 1972 and June 1972 were examined and their gut-contents compared.

Observations

Food and feeding habits:

The observations on the gut-contents of silver carp and catla by Alikunhi and Sukumaran (1964) have shown that both are plankton feeders and the differences in feeding habits are only structurally indicated. Singh (1972) has stated that silver carp competes for food with catla, both being surface feeders. According to Chakraborty (1972), silver carp and catla are both dwellers of the same strata of water in ponds and there is some overlapping in the food spectrum of these two species. Laxshmanan *et al.* (1971) have observed keen competition for the same type of food between catla and silver carp.

Like catla, silver carp has a terminal mouth indicating surface feeding habits. The presence of insignificant quantities of decayed organic matter and sand mixed with mud in the guts of the two species in most of the months[4] in Kulgarhi reservoir has also indicated that the two species rarely feed at bottom.

The gut length in young silver carp (size range; 52-367 mm) is 3.0 to 7.8 times the total length of the fish (Inaba and Nomura 1956). In the present study, the ratio of fish length to gut-length in adult silver carp (size range: 575-795 mm) has been found to vary from 1:4.36 to 1:8.6 (Av.-1:6.25) and is al-

[4] Only in the month of June when the water level in the reservoir was low, the guts of the two species were found to contain sufficient quantities of sand mixed with mud and the bottom debris.

most comparable to that of catla (Range—1:5.5 to 1:9.58; Av.-1:7.39). This seems to indicate that the food and feeding habits of the two species are almost the same, as the length of the gut depends on the nature of the food taken by the fish (Mookerjee and Das 1945).

The foregoing observations seem to give clue to the fact that when silver carp and catla are cultured together, they mutually compete for the same type of food. With a view to elucidate this point, the guts of the two species obtained during the corresponding months were examined for their contents. The overall composition of the gut-contents of silver carp and catla, as determined in the present study, has been compared and given in Table 1.

Table 1

Comparison of gut-contents of silver carp and catla from Kulgarhi reservoir

Items of gut-contents	Silver carp	Catla
Sand mixed with mud	13.29%	5.75%
Decayed organic matter	7.14	7.19
Digested matter	40.29	67.95
Blue-green algae	4.32	12.96
Green algae	9.09	0.43
Diatoms	3.76	1.79
Dinoflagellates	1.07	0.06
Rotifers	20.81	2.31
Copepods	0.23	1.30
Cladocerans	—	0.26

According to Inaba and Nomura (1956), silver carp has specialised structure of the gill rakers adapted to micro-plankton feeding and is predominantly phytoplankton feeder. Alikunhi and Sukumaran (1964) have observed that silver carp feeds predominantly on phytoplankton and it is an efficient converter of basic food, whereas catla is predominantly zooplankton feeder.

In the present case (vide Table 1), silver carp and catla have been found to subsist on almost equal quantities of phytoplankton (18.24% and 15.24% respectively). Among phytoplankton, the green algae was the most dominant (9.09%) in the diet of silver carp, followed by blue-green algae (4.32%), diatoms (3.76%) and dinoflagellates (1.07%), whereas catla was found to feed predominantly on blue-green algae (12.96%) and insignificantly on diatoms (1.79%), green algae (0.43%) and dinoflagellates (0.06%). *Melosira, Eunotia, Cyclotella* and *Navicula* among diatoms; *Chlorella, Gloeocystis, Scenedesmus, Coelastrum* and *Tetraedron* among green-algae; *Microcystis* and *Merismopedia* among blue-green algae; *Peridinium* and *Ceratium* among dinoflagellates were the most dominant in the diet of silver carp. *Melosira* and *Cyclotella* among diatoms: *Gloeocystis* and *Scenedesmus* among green algae: *Microcystis* among blue-green algae; and *Peridinium* and *Ceratium* among dinoflagellates were likewise the most dominant in the diet of catla. In the guts of silver carp, the zooplankton (21.04%) was made up almost entirely of rotifers (20.81%), the only other component insignificantly represented being copepods (0.23%). Catla is known to be mainly zooplankton feeder. As the foregut in catla has a rudimentary stomach in the form of slightly dilated bulb, most of the crustaceans (copepods and cladocerans) get digested. As such the bulk of this group is encountered in digested condition (67.95%) and very little of it is in identifiable condition (copepods: 1.3% and cladocerans: 0.26%). In the diet of silver carp, *Keratella* among rotifers and *Cyclops* among copepods were the most common forms, whereas in the diet of catla, *Keratella* among rotifers; *Cyclops*, Nauplius and *Diaptomus* among copepods; and *Bosmina* and *Daphnia* among cladocerans were

the most common forms.

The observations on the feeding intensity of silver carp and catla have indicated that the former is more voracious feeder than the latter. 50% of the guts of silver carp were full, the gastrosomatic index being 20.05. In comparison to silver carp, catla appears to be a moderate feeder (9.1% of the guts full and the gastrosomatic index—7.4). As catla feeds on crustaceans (nutritiously rich food), it

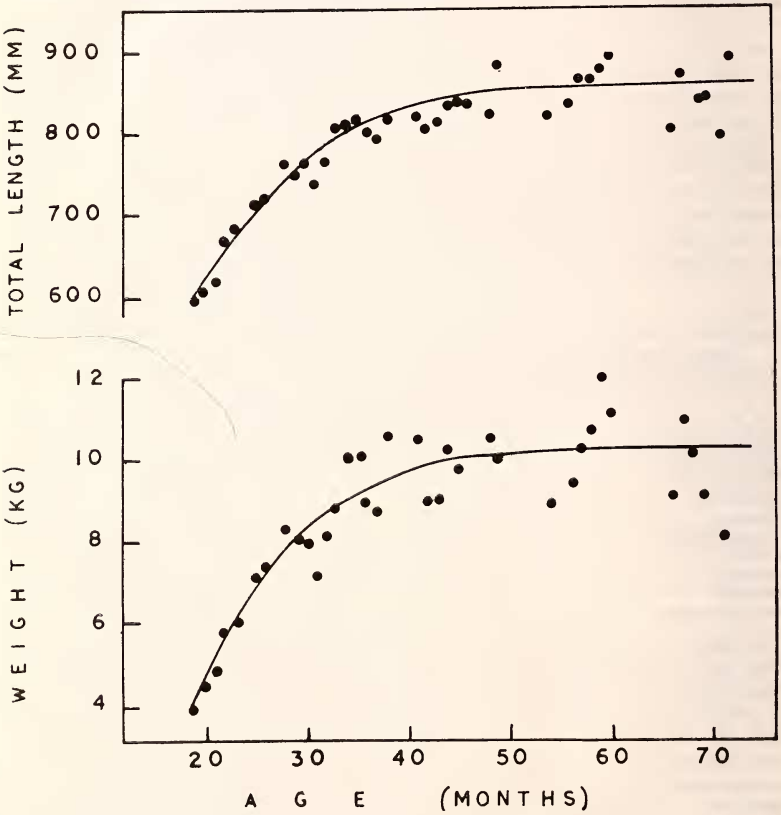

Fig. 1. Growth pattern, by length and weight, of catla (1966 brood).

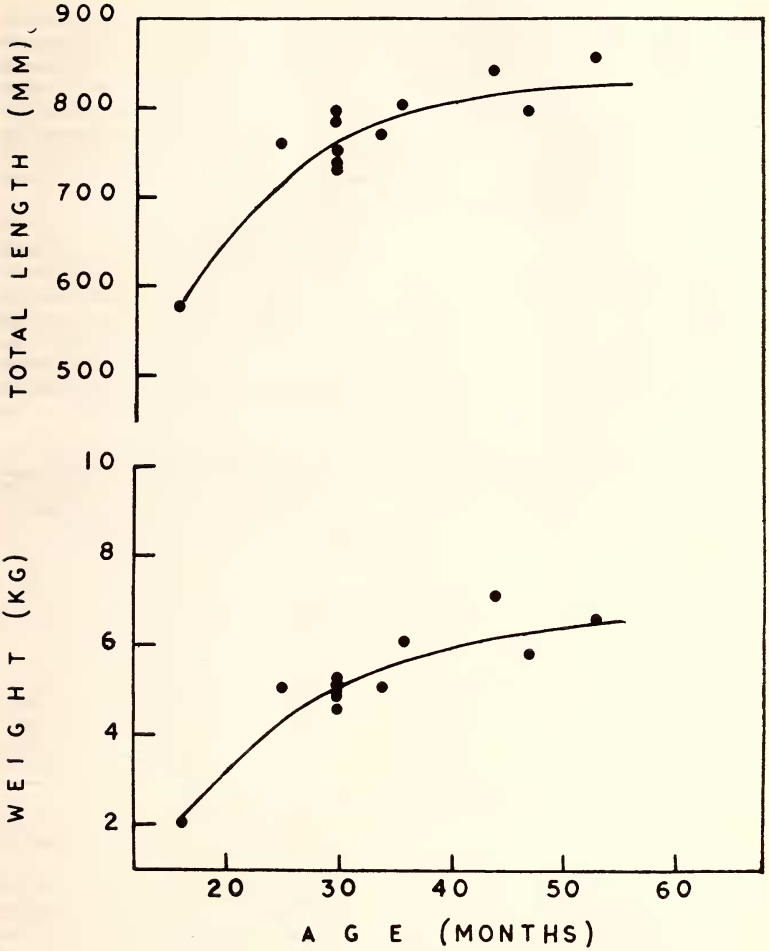

Fig. 2. Growth pattern, by length and weight, of silver carp (1968 brood).

requires comparatively little quantity of food for its normal fast growth. On the other hand, silver carp feeds abundantly on rotifers and sparingly on copepods. The two species subsist on almost equal quantities of phytoplankton. The food of silver carp is therefore not so nutritiously rich as that of catla. Hence, it is imperative that in order to attain fast growth, silver carp consume food at faster rates than catla.

Growth:

As already stated, the fingerlings of catla were stocked in the reservoir for the first time in the year 1966 and again in the year 1968. From the fact that the reservoir was not stocked with catla in the year 1967, it has been possible to separate catla specimens belonging to 1966 and 1968 broods captured from February 1968 to June 1972 and assign age to the individual fish in terms of months on the basis of date of their capture. As the fingerlings of silver carp were stocked in the reservoir only once in February 1969, the age in terms of months of 12 silver carp captured from the reservoir has also been determined from the date of their recovery (vide Appendix I). Based on the data on growth by length and weight of catla and silver carp, the growth curves for the two species have been drawn in figs. 1 and 2, and the growth in terms of months, as has been read off from the curves, is presented in Table 2.

From the analysis of growth data on silver carp and catla, the following facts emerged:

(i) The growth of silver carp was fast in the early period, i.e. upto 25 months (fig. 2), when the plankton was abundant and silver carp could feed voraciously on rotifers. But the growth of silver carp showed decline in the later period, i.e. in following 25 to 50 months, when rotifers were poorly represented in plankton (vide Table 3).

(ii) Catla belonging to 1966 brood showed normal growth up to the time silver carp was absent in the reservoir, but with the introduction of silver carp in February 1969, catla

TABLE 2

GROWTH OF SILVER CARP AND CATLA IN KULGARHI RESERVOIR

Date	Age (in months)	Total length (mm)	Growth rate (mm)	Weight (kg)	Growth rate (kg)
		SILVER CARP			
March '70	20	650	—	3.00	—
January '71	30	760	110	5.25	2.25
November '71	40	800	40	6.00	0.75
September '72	50	830	30	6.50	0.50
		CATLA			
March '68	20	610	—	4.50	—
*January '69	30	760	150	8.25	3.75
November '69	40	825	65	9.75	1.50
September '70	50	850	25	10.00	0.25
July '71	60	855	5	10.25	0.25
May '72	70	855	0	10.25	0.00

* Silver carp was introduced in the reservoir in February 1969.

showed retarded growth thereafter (fig. 1). Catla belonging to 1968 brood showed extremely poor growth from the very beginning.

From the above observations, it is evident that the culture of silver carp in Kulgarhi reservoir has adversely affected the growth of catla.

Remarks

It is evident from the data presented that the growth of catla has greatly suffered since the time silver carp was introduced in Kulgarhi reservoir. Alikunhi and Sukumaran (1964) and Sukumaran *et al.* (1969) have stated that catla adversely suffers in competition for food in presence of silver carp. According to Singh (1972), silver carp competes for food with catla, both being surface feeders and the former grows much faster than the latter. Laxshmanan *et al.* (1971) have observed that the Indian carps and the Chinese carps compete to some extent for the same type of food and this competition is more pronounced between catla and silver carp. Chakraborty (1972) has also observed that catla and silver carp are both dwellers of the same strata of water in ponds and though the former feeds prodominantly on zooplankton and the latter predominantly on phytoplankton, there appears to be some overlapping in the food spectrum of these two species. The observations on the feeding habits of silver carp in Kulgarhi reservoir have, however, indicated that it is a more voracious feeder than catla and it feeds predominantly on rotifers. These observations are amply confirmed when the data on the yearly fluctuations in plankton population of Kulgarhi reservoir from 1968-69 to 1971-72, presented in Table 3, is critically examined. As is seen from this table, the population of rotifers and in turn that of zooplankton has suffered sharp decline immediately after the introduction of silver carp in the reservoir and the lower level of rotifers and con-

Table 3

Yearly fluctuations in plankton count (Units per litre) in the surface collection samples of Kulgarhi reservoir from 1968-69 to 1971-72.

Plankton	1968-69	1969-70	1970-71	1971-72
Diatoms	53.0	106.2	32.6	6.0
Green algae	1.5	8.1	18.8	11.5
Blue-green algae	14.8	17.7	31.1	19.3
Dinoflagellates	123.3	184.2	150.9	5.0
PHYTOPLANKTON	192.6	316.2	233.4	41.8
Protozoans	13.7	15.9	36.6	0.9
Rotifers	155.6	45.4	63.6	7.1
Copepods	34.7	28.0	15.0	8.6
Cladocerans	6.7	1.9	6.6	2.6
ZOOPLANKTON	210.7	91.2	121.8	19.2
TOTAL PLANKTON	403.3	407.4	355.2	61.0

sequently that of zooplankton concentrations has continued to prevail during subsequent years (1969-70 to 1971-72). This phenomenon cannot be considered merely a coincidence, as rotifers in large quantities have been encountered in the guts of silver carp. Moreover, the depletion in rotifer population in Kulgarhi reservoir, which has been recently constructed, cannot be attributed to trophic depression (referred to by Jhingran 1965), as in that case the entire plankton population would have suffered depletion, which does not happen to be the case here. The total plankton, on the contrary continued to maintain almost the same level (355.2 to 407.4 u/l) during the first three years (1968-69 to 1970-71).

Since catla does not feed exclusively or even abundantly on rotifers, silver carp by feeding on rotifers does not seem to compete directly with catla in food. The overwhelming preference for rotifers (mostly *Keratella*) by silver carp has probably created imbalance in plankton production cycle, greatly affecting the production of zooplankton, which constitutes the main food of catla. Thus, it is probable that catla indirectly suffers in the presence of silver carp. Furthermore, silver carp is known to grow faster than catla (Alikunhi and Sukumaran 1964, and Singh 1972). It is therefore imperative that in order to maintain faster growth, silver carp devours plankton at faster rate. Singh (1972) also stated that silver carp has the capacity to utilize the natural food (phyto-and zoo-plankton) efficiently. As such, it is not difficult to visualize that in any body of water populated with silver carp, if the rate of plankton production does not keep pace with that of plankton consumption by silver carp, such waters would soon result in poor productivity and affect the normal growth of major carps, particularly catla, cultured along with it. It may therefore be surmised that it would not be a profitable proposition to culture silver carp along with catla in the reservoir. In view of these considerations, it is deemed proper to undertake further detailed biological studies on silver carp before its introduction in Indian reservoirs for large scale cultivation. In this context, Alikunhi and Sukumaran (1964) have expressed the view that 'further detailed observations are necessary before decision is taken about large-scale introduction of silver carp for cultivation in ponds in India'. Singh (1972) has also expressed the opinion that 'the question of release of silver carp in open waters where it could exercise some adverse effect on major carps fishery, particularly of catla, may await further investigations', as 'hasty transplantations for hobby or trade are likely to prove hazardous'.

Silver carp is reported to have more or less similar breeding habits as those of Indian major carps (Chaudhuri 1969) and it has been found to breed naturally in Tone river of Japan (Konradt 1968) and in Ah Kung Tian reservoir of Taiwan (Tang 1963). Instances of breeding of major carps in Indian reservoirs under suitable conditions are not rare. If silver carp is stocked in Indian reservoirs on large scale and it starts breeding in them naturally, it may prove to be a menace to the culture fishery of these waters.

Acknowledgements

We are grateful to Dr. V. G. Jhingran, Director and Dr. Y. R. Tripathi former Deputy Director, of this Institute for their keen interest in this work and to Dr. A. V. Natarajan, Scientist S-3 and to Shri J. C. Malhotra, Scientist S-3 for going through the manuscript critically. Thanks are due to Shri G. K.

Bhatnagar, Scientist S-2 and Shri P. N. Jaitley, Senior Research Assistant, for placing the plankton data of Kulgarhi reservoir at our disposal.

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* Not referred in original.

APPENDIX I

DETAILS OF RECOVERY OF SILVER CARP FROM KULGARHI RESERVOIR DURING THE PERIOD 3.12.1969 TO 22.12.72.

Sl. No.	Date of recovery	*Age (in months)	Total length (mm)	Weight (kg)	Sex
1	3.12.69	16	575	2.00	M
2	5.9.70	25	755	5.00	F
3	5.2.71	30	728	5.00	M
4	15.2.71	30	727	4.50	M
5	15.2.71	30	795	5.00	M
6	15.2.71	30	744	5.00	M
7	17.2.71	30	777	5.00	M
8	4.4.71	34	768	5.00	M
9	23.7.71	36	800	6.00	F
10	28.3.72	44	835	7.00	F
11	28.6.72	47	790	5.75	M
12	22.12.72	53	850	6.50	M

* Counted from August 1968.